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PNEUMATIC TIRE FOR HEAVY LOADS
[Juukajuu you kuukiiri taiya]

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SPECIFICATION /23*

1. Title of the Invention

Pneumatic Tire for Heavy Loads

2. Claims

A pneumatic tire for heavy loads characterized by:

(I) the block rows in the tread crown center region being composed of polygonal blocks divided by at least 3 main broken-line grooves that are aligned in parallel along the tire's circumferential direction and that have intermittent groove components that are parallel to one another at least in the tire's circumferential direction and by multiple auxiliary grooves that are provided at prescribed intervals between said main broken-line grooves that are mutually adjacent in a manner such that the directions of inclination change alternately;

(II) the block rows in the tread shoulder regions being composed of blocks that are divided by said main broken-line grooves that are closest to the shoulder sides, by the shoulder-side rims, and by auxiliary grooves that connect the above two at the locations of the groove components, from among said groove components that are parallel in the tire's circumferential direction, that protrude toward the shoulder sides; and

(III) the blocks of said (I) and (II) having cuts that run across the tire's circumferential direction.

* Numbers in the margin indicate pagination in the foreign text.

3. Detailed Explanation of the Invention

[Field of Industrial Application]

The present invention pertains to pneumatic tires for heavy loads that satisfy both braking and driving performances on icy/snowy road surfaces and driving stability and abrasion resistance on dry road surfaces, etc.

[Prior Art]

As pneumatic tires for heavy loads, such as truck tires or bus tires, there conventionally have been tires having a tread pattern obtained by means of the following: forming block groups by providing relatively large, multiple broken-line or zigzag main grooves [1] that extend in the direction of the tire's circumference in the tread crown center region [C] and by providing in the shoulder regions [S] rows of block groups that have lug grooves [2] that open on the outside of the tread crown center region [C]; and further dividing the block groups with sub-grooves [3] having small widths. While this tread pattern has excellent tire braking and driving performance on snowy roads, it has a shortcoming in that it is likely to cause lopsided wear, called heel-and-toe wear /24
or shoulder wear, on dry roads, etc. Moreover, aside from said lopsided wearing properties, the volume of the grooves is made to be large in order to secure the braking and driving performance on snow, and therefore, the groove percentage of the tread surface is 45%~50%, which is high. This made the wear resistance itself poor. Moreover, since the blocks are individually divided into small sizes, the rigidity of the blocks is low, and the stability of the vehicle obtained during cornering on

dry roads, etc. is much lower than that of, for example, a rib pattern.

Moreover, Fig. 4 is a plan view of a tread pattern of a conventional tire called an all-season pattern. Compared to the above-mentioned conventional tire, its wear resistance can be improved by making the individual blocks large and by setting the groove percentage to be 35%~40%, but a decrease in the braking and driving performances on snowy roads cannot be avoided. Moreover, although the heel-and-toe wear or shoulder wear is improved in comparison with a tire with the tread pattern of Fig. 3, the improvement is not sufficient. When using a steering shaft, it is difficult to avoid a decrease in the heel-and-toe wear or shoulder wear, and even if a countermeasure is taken by partially reducing the depth of the lug grooves, satisfactory results cannot be obtained, and if anything, the braking and driving performances deteriorate.

Furthermore, although a conventional pneumatic tire for heavy loads satisfies the braking and driving performances on roads covered with soft snow, sufficient performances cannot be obtained on hard road surfaces covered with compacted snow or on frozen road surfaces, and it was necessary to use chains as aids or to change to spiked tires.

[Purpose of the Invention]

The purpose of the present invention is to eliminate the shortcomings of said conventional pneumatic tires for heavy loads and to supply a pneumatic tire for heavy loads provided with a tread pattern that exhibits sufficient braking and driving performances on icy/snowy roads during winter (not only roads covered with soft snow, but also hard roads that are covered with compacted snow and even frozen roads), that inhibits

the occurrence of lopsided wear on dry road surfaces, and that has excellent wear resistance.

[Structure of the Invention]

Such a purpose of the present invention can be achieved by means of tires that are characterized by the following: (I) the block rows in the tread crown center region being composed of polygonal blocks divided by at least 3 main broken-line grooves that are aligned in parallel along the tire's circumferential direction and that have intermittent groove components that are parallel to one another at least in the tire's circumferential direction and by multiple auxiliary grooves that are provided at prescribed intervals between said main broken-line grooves that are mutually adjacent in a manner such that the directions of inclination change alternately;

(II) the block rows in the tread shoulder regions being composed of blocks that are divided by said main broken-line grooves that are closest to the shoulder sides, by the shoulder-side rims, and by auxiliary grooves that connect the above two at the locations of the groove components, from among said groove components that are parallel in the tire's circumferential direction, that protrude toward the shoulder sides; and

(III) the blocks of said (I) and (II) having cuts that run across the tire's circumferential direction.

Preferably, the ratio ([a]/[L_1]) of the widths ([L_1]) of the blocks that compose said tread crown center region in the lateral direction of the tire and the lengths ([a]) of the center parts of said blocks in the direction of the tire's circumference should be within the range of

0.45~0.70, and the ratio ([b]/[L_2]) of the widths ([L_2]) of the blocks that compose the tread shoulder regions in the lateral direction of the tire and the lengths ([b]) of the center parts of said blocks in the direction of the tire's circumference should be within the range of 0.90~1.25.

In the following, the present invention will be explained in detail by referring to drawings.

Figure 1 is one plan view example for the explanation of the groove arrangement method of the tread pattern of the pneumatic tire for heavy loads (hereafter simply referred to as tire) of the present invention. As shown in the drawing, the tread crown center region [C] is provided with 3 broken lines, [5], [6] and [7] (which correspond to the main grooves), that are parallel along the tire's circumferential direction and that intermittently have line components, [20] and [20]', that are parallel in at least the tire's circumferential direction. From among these 3 broken lines, the closest bending points of said broken lines that are mutually adjacent ([8] and [12], [9] and [15]) are connected by lines, [16] and [17] (which correspond to the auxiliary grooves), and polygonal blocks that are divided by these auxiliary groove forming lines, [16] and /25 [17], and said broken lines, [5], [6], and [7], form the block rows, [2] and [3], of the tread crown center region [C].

On the other hand, in both tread shoulder regions [S], block rows, [1] and [4], are composed of blocks that are divided by the broken lines, [5] and [7], that are the closest to the shoulder regions, by the shoulder-side rims [18], and by lines [19] that connect the two at the

locations of the groove components [20], which are from among the groove components, [20] and [20′], that are parallel in the direction of the tire's circumference, that protrude toward the shoulder sides.

Figure 2 is a plan view that shows one example of the tread pattern of the tire of the present invention that was prepared by the groove arrangement method of Fig. 1. Note that the adjacent broken lines ([8] and [12], [9] and [15]) of the tread crown center region [C] are connected by step-like lines, [16] and [17].

All of these blocks of the tread crown center region [C] and shoulder regions [S] are provided with multiple cuts.

First, in the present invention, the blocks that compose the tread surface are required to have said cuts [22] that cross the circumferential direction of the tire. In other words, in a case in which a braking or driving force is applied to the tire tread on a icebound road surface, multiple edges of each block divided by the cuts [22] provided to said blocks scrape the thin water film on the icy surface, increase the adhesion between said icy surface and the tread's rubber surface, and increase the efficiency of the frictional resistance of said tread surface against the icy surface.

Moreover, in the case of a road covered with compacted snow, the edges of said blocks become engaged with said firmly hardened road surface covered with compacted snow, and the resistance of the tread surface increases. Moreover, in addition to the above-mentioned edge effects of the blocks, the ground-contact properties between each block and the road surface are improved while the driving or braking force is being applied

to the tire's tread surface because of the edge effects of the cuts provided to the block surface. In other words, Figs. 5 and 6, respectively, are cross-sectional drawings showing the transformed states of a block [B] that has no cuts [22] and of a block [B] that has multiple cuts [22] when a driving force (arrow) is applied to them, and they are also plan views that show the ground-contact patterns of said blocks [B]. As shown in (a) of Figs. 5 and 6, when a driving force (arrow) is applied to the blocks [B], the blocks [B] become transformed by the shearing force. However, parts of the blocks on the opposite side of the force application are lifted from the road surface and are not in contact with the road surface (white-out portions of (b) of Figs. 5 and 6). As is clear from the drawings, the block of Fig. 5(a) that does not have cuts [22] comes into contact with the road surface on only a part of its surface, whereas the block of Fig. 6(a) provided with the cuts [22] is in contact with the road surface on approximately the entire surface, as shown in Fig. 6(b). In other words, providing a block with cuts increases said block's edge effects and the frictional force against the road surface (compacted-snow road and icy road). The effects of such cuts provided to a block in increasing the ground-contact properties are observed on dry roads as well as on the above-mentioned compacted-snow roads and icy roads. When a block has no cuts, the sliding frictional energy of the non-contacting part is high and becomes a cause of heel-and-toe wear, but this does not occur in a block with cuts.

The cuts provided to the blocks of the tire of the present invention should be provided in the direction in which they cross the tire's

circumferential direction, preferably at an angle within the range of 90º~70º with respect to the tire's circumferential direction, in order to provide the above-described edge effects more effectively. Their shapes are preferably linear, but curved or stepped shapes are also permissible. As for the depth of said cuts, at least 60% of the depth of the main grooves is preferred in order to achieve an effect up to the snow wear limit indication (50% of the main grooves' depth) on an icy road. Moreover, the pitch (interval of the cut rows) of said cuts is 6~20mm, preferably in the range of 8~15mm. In other words, in the case of a tire to which the applied load is heavy, such as a tire for heavy loads, if the pitch is too narrow with respect to the alignment direction and depth of said cuts, the block rigidity decreases, the blocks collapse when contacting the ground, the ground-contact properties decrease, and in the worst case, chipping of the blocks occurs. Moreover, a pitch that is too wide is not preferred, either, since the ground-contact properties of the blocks /26 decrease.

As for the thickness of said cuts, the thinner they are, the better it is. 0.8mm or less is preferred. In particular, it is preferred that these cuts be provided by cutting the tire's tread after vulcanizing instead of by using a tire mold. When providing cuts by using a mold, the range of 0.4~0.8mm is preferred from the perspective of the strength of the cutting material.

The tire of the present invention has the above-described block pattern, which is divided by at least 3 main broken-line grooves containing intermittent groove components that are parallel in the tire's

circumferential direction and by multiple auxiliary grooves that are provided between said main grooves that are mutually adjacent at prescribed intervals with alternately different inclination directions. In other words, the block pattern is divided by meshed grooves. Such a block pattern enables the tread surface to become engaged with snow effectively while driving on a road surface covered with snow (soft road surface). Moreover, as shown in Fig. 2, blocks having dimensions that are larger in the lateral direction than in the tire's circumferential direction are placed in parallel in said tread crown center region [C]. Therefore, it is possible to effectively provide these blocks with multiple thin cuts. Moreover, there is no pitch shifting in the alternately placed auxiliary grooves and block rows.

Moreover, by providing auxiliary grooves, [16] and [17], that connect said adjacent main broken-line grooves and that are positioned in alternately opposite directions with respect to the tire's circumferential direction, the block rows of the tread crown center region [C], for example, the block rows [2] and [3] of Fig. 2, become positioned in parallel in a zigzag manner. Therefore, shifting of the pitches in the alternating auxiliary grooves and block rows that is seen in the conventional tires shown in Figs. 3 and 4 does not occur, and excellent braking and driving performances can be obtained. Moreover, since no sharp angles are formed on the outlines of the blocks, there is an effect of inhibiting heel-and-toe wear.

For the conventional tires shown in Figs. 3 and 4, the pitches are shifted in order to prevent the occurrences of heel-and-toe wear. However,

when pitches are shifted for a tire that has large loads applied to it, as in the case of a tire for heavy loads, it is difficult to simultaneously reduce said wear and obtain preferable braking and driving performances. As opposed to this, the tire of the present invention is advantageous since it makes it possible to simultaneously prevent heel-and-toe wear from occurring and obtain preferable braking and driving performances by means of the synergy effect of the above-described cuts of the blocks. Moreover, since said block rows are placed in parallel, it is possible to effectively provide multiple thin cuts to said blocks. Also, since no sharp angles are formed on the outlines of the blocks, the occurrence of heel-and-toe wear can be inhibited.

The depth of the auxiliary grooves provided to the tread surface of the present invention should preferably be within the range of 0.5~0.8 times the depth of the main grooves. In other words, by increasing the block rigidity in the rim parts ([9]-[16], [11]-[18]) of the block rows ([2] and [3]) of the tread crown center region [C] that are parallel in the direction of the tire's circumference, by providing thin cuts to the center areas of said blocks, by reducing the rigidity of the center parts of the blocks, and by reducing the rigidity in the area between this and the blocks' rims in terms of the tire's circumferential direction, heel-and-toe wear can be inhibited and the tire's ground-contact properties can be made excellent.

Moreover, as for the blocks that make up the block rows of the tread crown center region, it is preferred that their shapes and the lengths of the groove components ([20] and [20'] of Fig. 1) that are on both the

left and right sides and that are parallel in the tire's circumferential direction be the same (excepting a pitch variation range provided as a noise countermeasure). If the sizes of the blocks are different in the tire's circumferential direction, it may be disadvantageous in terms of heel-and-toe wear since a difference in rigidity is created.

Moreover, as for the block rows of the shoulder ranges [S], it is preferred that their dimensions be larger than those of the blocks of the tread crown center region [C] and that the ratio ([b]/[L_2]) between the width [L_2] in the tire's lateral direction and the length [b] in the tire's circumferential direction be within the range of 0.90~1.25. In other words, blocks that have large dimensions and stable shapes and that satisfy the above ratio ([b]/[L_2]) reduce the groove percentage of the shoulder regions and increase the tread density. Therefore, they are effective in increasing the stability obtained when cornering on dry road surfaces and in inhibiting shoulder wear when a steering shaft is /27 mounted.

Moreover, as for the above blocks of the tread crown center region, it is preferred that the ratio ([a]/[L_1]) between the width [L_1] in the tire's lateral direction and the length [a] in the tire's circumferential direction be within the range of 0.45~0.70. By this, it is possible to obtain snow-engaging properties on soft snow and excellent ground-contact properties on hard compacted snow or icy surfaces.

Moreover, in order to increase.the actual ground contact area of the tread of the tire of the present invention, to effectively utilize frictional resistance on icy surfaces, and to maintain excellent wear

resistance, it is preferred that the groove percentage of the entire tread be within the 30~40% range.

[Working Examples]

In the following, the present invention and its effects will be explained concretely based on working examples.

Working Example 1

The following 3 types of tires were prepared.

Tire of the Present Invention: A tire that has a tire size of 10.00R20 14PR, the following dimensions, and the tread pattern of Fig. 2.

Expanded tread width = 214mm, groove percentage = 36%, main groove depth = 19.5mm, and auxiliary groove depth = 15mm,

The number of cuts of each of the blocks that make up the block rows of the tread crown center region = 2,

The depth of the cuts of each of the blocks that make up the block rows of the shoulder regions = 14.5mm (about 3/4 of the depth of the main grooves), pitch = 11~13mm, number of cuts = multiple, $a/L_1 = 0.54$, $b/L_2 = 1.06$.

Moreover, the rigidity of the center blocks was made to be even in the circumferential direction by allowing the auxiliary grooves that connect the bending points of the main grooves to double back (As shown in Fig. 7, the straight-line portions that connect the bending points are linear all the way through even when they double back, so that the snow-engaging properties will not be spoiled).

Conventional Tire A:

A tire that has a tire size of 10.00R20 14PR, the following dimensions, and the tread pattern shown in Figure 3.

Expanded tread width = 220mm, groove percentage = 47%, main groove depth: 19.5mm.

Conventional Tire B:

A tire that has a tire size of 10.00R20 14PR, the following dimensions, and the tread pattern shown in Fig. 4.

Expanded tread width = 200mm, groove percentage = 37%, main groove depth: 17.0mm.

Wear Performance Evaluations:

Test tires were attached to all of the wheels of a test truck, and the vehicle was driven for 50,000m.

Heel-and-toe wear was investigated based on the level differences of the blocks in the tire's circumferential direction after the actual driving of the vehicle, and the shoulder wear was investigated based on the level differences of the block rows of the tread crown center region and the block rows of the shoulder regions. Smaller measurement values (relative index values) correspond to better performance with regard to wear.

Moreover, the estimated tool lives were evaluated based on the wear amounts of the grooves. Higher values (relative index values) correspond to longer estimated tool lives.

Braking and Driving Performance Evaluations:

On a road covered with compacted snow and on an icy road, braking was started at a vehicle velocity of 30Km, and the distances reached when the vehicle stopped were measured. Smaller measurement values (relative index values) correspond to better braking performance.

Moreover, the hill-climbing performance was evaluated by measuring the time it took to pass through a certain distance on a slanted road surface covered with soft snow. Smaller measurement values (relative index values) correspond to better hill-climbing performance.

The evaluation results are indicated in Table 1 as relative index values that were obtained by assuming the measurement values of the conventional tire [A] to be 100.

Table 1 /28

		Conventional Tires		Tire of the Invention
		A	B	
Wear Performance	Heel-and-tow (level difference)	100	73	18
Wear Performance	Shoulder wear (level difference)	100	52	15
Wear Performance	Estimated tool life	100	108	124
Braking and Driving performance	Braking distance on compacted-snow road	100	119	82
Braking and Driving performance	Braking distance on icy road	100	98	87
Braking and Driving performance	Hill-climbing time on snow-covered road	100	122	99

[Effects of the Invention]

According to the present invention, a tire for heavy loads can exhibit high-level braking and driving performances on roads during winter,

including not only snow-covered roads but also roads covered with compacted snow or ice. It also has excellent driving properties and wear resistance on dry road surfaces, and its tool life can be greatly extended.

4. Brief Description of the Drawings

Figure 1 is a plane view for explaining the tread pattern arrangement method of the tire of the present invention. Figure 2 is a plane view that shows one mode of the tread pattern of the tire of the present invention. Figure 3 and Figure 4 are plane views of the tread patterns of conventional tires. Figure 5 (a) and (b) and Figure 6 (a) and (b), respectively, are cross-sectional drawings showing the transformed states of a block with no cuts and a block with multiple cuts and plan views that show the corresponding ground-contact patterns of those blocks, and Figure 7 is a partial plane view that shows blocks of the tire of the present invention.

[1], [2], [3], [4] = block row; [5], [6], [7] = circumferential-direction main groove; [8]~[15] = bending point; [16], [17] = auxiliary groove; [18] = shoulder-side rim; [19] = auxiliary groove (lug groove); [20], [20'] = groove components that are parallel in the tire's circumferential direction; [C] = tread crown center region; [S] = tread shoulder region.

Figure 1

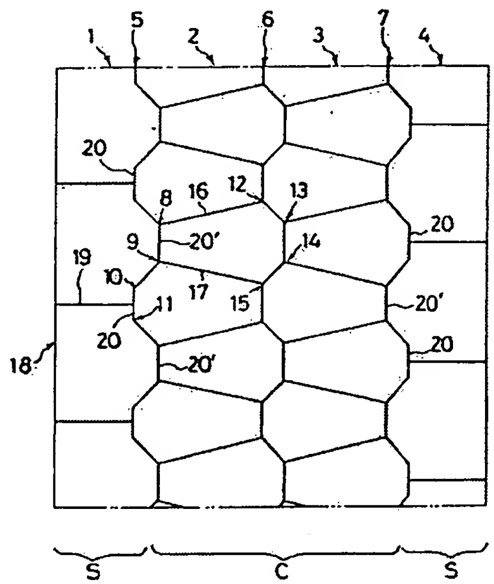

Figure 2

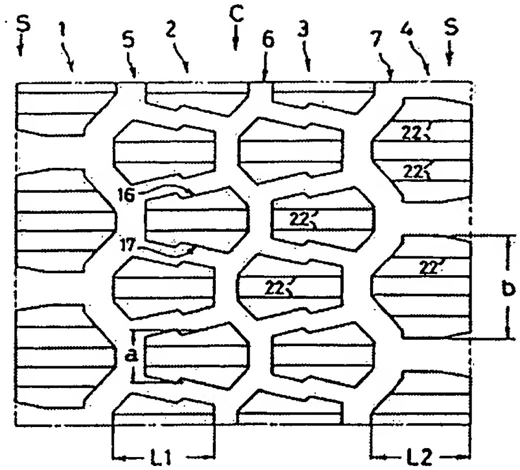

Figure 3

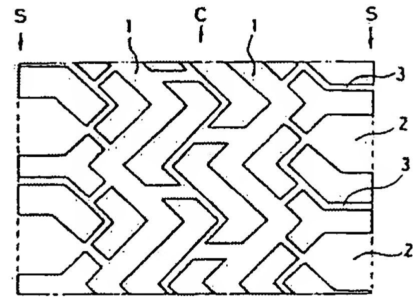

Figure 4

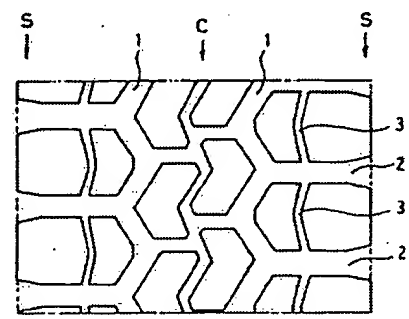

Figure 5

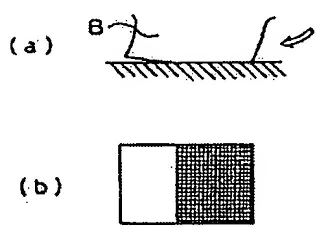

Figure 6

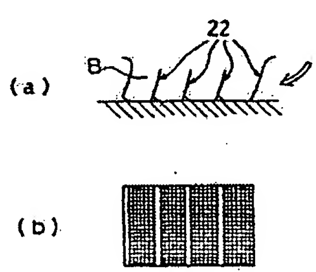

Figure 7